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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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Office Action Summary	Application No. 10/567,239	Applicant(s) HIWATASHI ET AL.	
	Examiner Ben Lewis	Art Unit 1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-47 is/are pending in the application.
4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-18, 22-24, 26, 28-36, 38-42 and 44-47 is/are rejected.
- 7) ☒ Claim(s) 19-23, 25, 27, 37 and 43 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 03 February 2006 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date <u>4/29/08, 2/3/06</u> . | 6) <input type="checkbox"/> Other: ____. |

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.
2. Claim 47 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.
3. Regarding claim 47, the phrases "the 3% diameter" and "the 97% diameter" renders the claim indefinite because it is unclear as to what this phrase encompasses. Also, there is insufficient antecedent basis for this limitation in the claims.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.
5. Claim 1, 2, 5-9 and 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633).

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With respect to claim 1, 2, 5-7, Kawasaki et al. disclose a solid oxide fuel cell wherein, Kawasaki et al. disclose an air electrode and fuel electrode (Col 11 lines 45-60). Kawasaki et al. disclose a perovskite oxide air electrode containing manganese (Col 13 lines 2-11). Kawasaki et al teach that referring to FIG. 13, in the example 13, manganese was contained in an amount of about 14 atom % near a boundary between the solid electrolyte film and the air electrode (the opposing electrode). The boundary correspond to a position at which the distance shown in FIG. 13 is 300 μm . The amount of manganese contained in the film was gradually decreased as the position at which the amount was measured approaches to a boundary between the film and the fuel electrode substrate. The boundary correspond to a position at which the distance shown in FIG. 13 is 100 μm . (Col 25 lines 9-32). Kawasaki et al. does not specifically teach the content of manganese being 0.3 to 4% by weight. However, Kawasaki et al. teach that when Mn was the selected metal element, as understood from the examples 1 to 6 and the comparative example 2 to 5, when Mn was contained in the film in an amount of not less than 1 atom %, the electromotive force was more than 1 V, and the air-tight performance of the film was considerably improved. When Mn was contained in the film in an amount of more than 15 atom %, the resistance was increased. In particular, when the amount was 3-12 atom %, the air-tight performance was sufficiently high and the resistance was most reduced (Col 23 lines 19-28). Therefore, it would have been within the skill of the ordinary artisan to adjust the amount of Mn in the surface layer of the fuel side of the solid electrolyte to be within Applicant's claimed % wt. range in order to improve air-tight performance and keep resistance low. *Discovery*

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of optimum value of result effective variable in known process is ordinarily within skill of art. In re Boesch, CCPA 1980, 617 F.2d 272, 205 USPQ215.

With respect to claims 8 and 9, Kawasaki et al teach that referring to FIG. 13, in the example 13, manganese was contained in an amount of about 14 atom % near a boundary between the solid electrolyte film and the air electrode (the opposing electrode). The boundary correspond to a position at which the distance shown in FIG. 13 is 300 μm . The amount of manganese contained in the film was gradually decreased as the position at which the amount was measured approaches to a boundary between the film and the fuel electrode substrate. The boundary correspond to a position at which the distance shown in FIG. 13 is 100 μm . (Col 25 lines 9-32). Kawasaki et al. does not specifically teach the content of manganese being less than 10% by weight or less than 6% by weight on the air electrode side. However, Kawasaki et al. teach that when Mn was the selected metal element, as understood from the examples 1 to 6 and the comparative example 2 to 5, when Mn was contained in the film in an amount of not less than 1 atom %, the electromotive force was more than 1 V, and the air-tight performance of the film was considerably improved. When Mn was contained in the film in an amount of more than 15 atom %, the resistance was increased. In particular, when the amount was 3-12 atom %, the air-tight performance was sufficiently high and the resistance was most reduced (Col 23 lines 19-28). Therefore, it would have been within the skill of the ordinary artisan to adjust the amount of Mn in the surface layer of the air side of the solid electrolyte to be within Applicant's

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claimed % wt. range in order to improve air-tight performance and keep resistance low.

Discovery of optimum value of result effective variable in known process is ordinarily within skill of art. In re Boesch, CCPA 1980, 617 F.2d 272, 205 USPQ215.

With respect to claim 38, Kawasaki et al. teach that in first, second, third, fourth and fifth aspects of the present invention, the air electrode may be formed of doped or undoped LaMnO_3 , CaMnO_3 , LaNiO_3 , LaCoO_3 , LaCrO_3 or the like, among which LaMnO_3 doped with strontium or calcium is preferable. These doped or undoped LaMnO_3 , CaMnO_3 , LaNiO_3 , LaCoO_3 and LaCrO_3 include a composite oxide having a perovskite structure in which its A site and B site are not substantially deficient, and include a composite oxide in which a part of the A site or B site is deficient, for example, in which La or Ca is contained in the A site and a part of the A site is deficient. Such composite oxide, in which La or Ca is contained in the A site and a part of the A site is deficient, effectively reduce the formation of $\text{La}_2\text{Zr}_2\text{O}_7$. Generally, the air electrode may be preferably made of a nickel-zirconia cermet or a cobalt-zirconia cermet (Col 17 lines 5-25).

. Kawasaki et al. also disclose an air electrode substrate having a porosity of 22% (Col 17 lines 35-67).

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6. Claims 3 and 39-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Sarkar et al. (U.S. Pub. No. 2004/0121222 A1).

With respect to claim 3, Kawasaki et al. disclose a solid oxide fuel cell above. Kawasaki et al. do not specifically teach a porous layer provided between the fuel electrode and the electrolyte. However, Sarkar et al. disclose a crack-resistant anode supported fuel cell (title) wherein, Sarkar et al. disclose a porous anode functional layer (AFL) with thickness between 1 and 20 μ m (Paragraph 0011), (Paragraph 0013), (Paragraph 0024). Sarkar et al. also disclose a porous buffer layer which serves as a physical buffer between the anode support layer and other functional layers which due to its high porosity provides a greater degree of compliance and minimizes the amount of stress imposed on the electrolyte layer (Paragraph 0033). Sarkar et al. also teach that the anode layer comprises YSZ (Paragraph 0013). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the anode functional layer/support layer/buffer layer configuration of Sarkar et al in to the fuel cell of Kawasaki et al. because Sarkar et al. teach that this configuration minimizes the amount of stress imposed on the electrolyte layer (Paragraph 0033).

Sarkar et al. also teach that the SOFC electrolytes are fully dense (non-porous) which is an excellent conductor of negatively charged oxygen (oxide) ions at high temperatures (Paragraph 0003). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the non porous

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electrolyte of Sarkar et al in to the fuel cell of Kawasaki et al. because Sarkar et al. teach that the non porous electrolyte has excellent conductivity (Paragraph 0003).

With respect to claims 39-41, Kawasaki et al. disclose a solid oxide fuel cell wherein, Kawasaki et al. disclose an air electrode and fuel electrode (Col 11 lines 45-60). Kawasaki et al. disclose a perovskite oxide air electrode containing manganese (Col 13 lines 2-11). Kawasaki et al teach that referring to FIG. 13, in the example 13, manganese was contained in an amount of about 14 atom % near a boundary between the solid electrolyte film and the air electrode (the opposing electrode). The boundary correspond to a position at which the distance shown in FIG. 13 is 300 μm . The amount of manganese contained in the film was gradually decreased as the position at which the amount was measured approaches to a boundary between the film and the fuel electrode substrate. The boundary correspond to a position at which the distance shown in FIG. 13 is 100 μm . (Col 25 lines 9-32). Kawasaki et al. does not specifically teach the content of manganese being 0.3 to 4% by weight. However, Kawasaki et al. teach that when Mn was the selected metal element, as understood from the examples 1 to 6 and the comparative example 2 to 5, when Mn was contained in the film in an amount of not less than 1 atom %, the electromotive force was more than 1 V, and the air-tight performance of the film was considerably improved. When Mn was contained in the film in an amount of more than 15 atom %, the resistance was increased. In particular, when the amount was 3-12 atom %, the air-tight performance was sufficiently high and the resistance was most reduced (Col 23 lines 19-28). Therefore, it would

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have been within the skill of the ordinary artisan to adjust the amount of Mn in the surface layer of the fuel side of the solid electrolyte to be within Applicant's claimed % wt. range in order to improve air-tight performance and keep resistance low. *Discovery of optimum value of result effective variable in known process is ordinarily within skill of art.* In re Boesch, CCPA 1980, 617 F.2d 272, 205 USPQ215.

7. Claims 4 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2).

With respect to claim 4, Kawasaki et al. disclose a solid oxide fuel cell above. Kawasaki et al. do not specifically teach a reaction layer is provided between the air electrode and the electrolyte. However, Wang et al. disclose a solid oxide fuel cell wherein, a novel cathode supported SOFC is shown in FIG. 3 and comprises a thick, porous, conductive support substrate (LSM) 30, and an LSM-YSZ composite layer 32 thereover (Col 5 lines 30-43). Cathode supported cells are preferred over anode supported cells because they can use alternative anode materials for hydrocarbon fuel cells without pre-reforming, and to obtain better cell performance (Col 10 lines 20-30). Therefore it would have been obvious to one of ordinary skill in the art to incorporate the cathode support structure of Wang et al. into the fuel cell of Kawasaki et al. because Wang et al. teach that cathode supported cells obtain better cell performance (Col 10 lines 20-30)..

With respect to claim 10, Kawasaki et al. teach that in first, second, third, fourth and fifth aspects of the present invention, the air electrode may be formed of doped or undoped LaMnO_3 , CaMnO_3 , LaNiO_3 , LaCoO_3 , LaCrO_3 or the like, among which LaMnO_3 doped with strontium or calcium is preferable. These doped or undoped LaMnO_3 , CaMnO_3 , LaNiO_3 , LaCoO_3 and LaCrO_3 include a composite oxide having a perovskite structure in which its A site and B site are not substantially deficient, and include a composite oxide in which a part of the A site or B site is deficient, for example, in which La or Ca is contained in the A site and a part of the A site is deficient. Such composite oxide, in which La or Ca is contained in the A site and a part of the A site is deficient, effectively reduce the formation of $\text{La}_2\text{Zr}_2\text{O}_7$. Generally, the air electrode may be preferably made of a nickel-zirconia cermet or a cobalt-zirconia cermet (Col 17 lines 5-25).

. Kawasaki et al. also disclose an air electrode substrate having a porosity of 22% (Col 17 lines 35-67).

8. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) in view of Browall et al. (U.S. Pub. No. 2003/0224232 A1).

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With respect to claim 11, Kawasaki et al. as modified by Wang et al. disclose a solid oxide fuel cell in paragraph 7 above. Kawasaki et al. teach that in first, second, third, fourth and fifth aspects of the present invention, the air electrode may be formed of doped or undoped LaMnO_3 , CaMnO_3 , LaNiO_3 , LaCoO_3 , LaCrO_3 or the like, among which LaMnO_3 doped with strontium or calcium is preferable. These doped or undoped LaMnO_3 , CaMnO_3 , LaNiO_3 , LaCoO_3 and LaCrO_3 include a composite oxide having a perovskite structure in which its A site and B site are not substantially deficient, and include a composite oxide in which a part of the A site or B site is deficient, for example, in which La or Ca is contained in the A site and a part of the A site is deficient. Such composite oxide, in which La or Ca is contained in the A site and a part of the A site is deficient, effectively reduce the formation of $\text{La}_2\text{Zr}_2\text{O}_7$. Generally, the air electrode may be preferably made of a nickel-zirconia cermet or a cobalt-zirconia cermet (Col 17 lines 5-25). Kawasaki et al. also disclose an air electrode substrate having a porosity of 22% (Col 17 lines 35-67).

Kawasaki et al. as modified by Wang et al. do not specifically teach cerium oxide in the air-side electrode reaction layer. However, Browall et al. disclose a fuel cell wherein, in other embodiments where the substrate comprises a cathode, disposing a plurality of sub-layers comprises disposing a first sub-layer comprising cerium oxide adjacent to, and in contact with, the cathode. Cerium oxide is a more ionically conductive compound than stabilized zirconia, but under certain fuel cell operating conditions, cerium oxide can be reduced to a form that is an electron conductor. To minimize the risk of shorting the cell, while maximizing the ionic conductivity of the

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electrolyte, cerium oxide is disposed only in the region adjacent to the cathode, where oxygen reacts with electrons generated by the electrochemical reaction of the cell (Paragraph 0019). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the cerium oxide at the cathode of Browall et al. into the solid oxide fuel cell of Kawasaki et al. as modified by Wang et al. in order to minimize the risk of shorting the cell (Paragraph 0019).

9. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) in view of Mazanec et al. (U.S. Patent No. 5,693,212).

With respect to claim 12, Kawasaki et al. as modified by Wang et al. disclose a solid oxide fuel cell in paragraph 7 above. Kawasaki et al. teach that in first, second, third, fourth and fifth aspects of the present invention, the air electrode may be formed of doped or undoped LaMnO_3 , CaMnO_3 , LaNiO_3 , LaCoO_3 , LaCrO_3 or the like, among which $\text{LaMnO}_{3.3}$ doped with strontium or calcium is preferable. These doped or undoped LaMnO_3 , CaMnO_3 , LaNiO_3 , LaCoO_3 and LaCrO_3 include a composite oxide having a perovskite structure in which its A site and B site are not substantially deficient, and include a composite oxide in which a part of the A site or B site is deficient, for example, in which La or Ca is contained in the A site and a part of the A site is deficient. Such composite oxide, in which La or Ca is contained in the A site and a part of the A site is deficient, effectively reduce the formation of $\text{La}_2\text{Zr}_2\text{O}_7$. Generally, the air electrode may be preferably made of a nickel-zirconia cermet or a cobalt-zirconia

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cermet (Col 17 lines 5-25). Kawasaki et al. also disclose an air electrode substrate having a porosity of 22% (Col 17 lines 35-67).

Kawasaki et al. as modified by Wang et al. do not specifically teach gallium containing perovskite oxide in the air-side electrode reaction layer. However, Mazanec et al. disclose a fuel cell wherein, a wide variety of metals and oxides of metals may be used to form perovskites useful in the present invention. In general, any combination of metals which satisfy the requirements of a perovskite may be used. Typical examples of such metals are the lanthanides, the metals of Groups Ia and IIa, the transition metals Al, Ga, Ge, etc. Examples of preferred metals include La, Co, Sr, Ca, Fe, Cu, Ni, Mn, Cr, Y, Ba, Ti, Ce, Al, Sm, Pr, Nd, V, Gd, Ru, Pb, Na, W, Sc, Hf, Zr, oxides thereof, and mixtures thereof. Bi and/or Ce are typically not required in the preferred embodiments, but may be present if desired. In one embodiment, Bi and/or Ce are present in amounts less than 13 mol % (Col 9 lines 33-50). Mazanec et al. also teach that oxidative coupling catalysts which may be used in the present invention include those which are used for oxidative coupling between hydrocarbons in the reaction mixture. Oxidative coupling catalysts useful for coupling of methane to form ethane and ethylene may be used in order to use methane as the second hydrogen-containing compound of the oxygen-consuming gas, and oxidative coupling catalysts may be used to facilitate the reaction between the hydrogen-containing aromatic compound and a second hydrogen-containing compound. Examples of oxidative coupling catalysts include oxides of lead, bismuth, tin, antimony, tellurium, cadmium, gallium, germanium, indium, zinc, calcium, and rare earth metals such as samarium, holmium, gadolinium,

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erbium, thulium, ytterbium, yttrium, lanthanum, neodymium, europium, dysprosium, lutetium, praseodymium, and terbium. A variety of doped magnesium oxides are also useful as oxidative coupling catalysts (Col 26 lines 1-25). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the gallium containing perovskite of Browall et al. into the solid oxide fuel cell cathode of Kawasaki et al. as modified by Wang et al. in order to oxidize the fuel within the fuel cell (Col 26 lines 1-25).

10. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) in view of Song et al. (U.S. Patent No. 7,285,347 B2).

With respect to claim 13, Kawasaki et al. as modified by Wang et al. disclose a solid oxide fuel cell in paragraph 7 above. Kawasaki et al. as modified by Wang et al. do not specifically teach the content of the manganese and nickel containing perovskite oxide in the air-side electrode layer is 30 to 70%. However, Song et al. disclose an anode supported solid oxide fuel cell wherein, the electrolyte slurry includes 60 to 95 wt % organic solvent such as 2-propanol and toluene, 5 to 40 wt % YSZ powder, and an additive. For example, when a concentration of the YSZ powder is less than 5 wt %, a slurry layer coated on an external surface of the anode-supported tube is too thin to form a dense electrolyte layer when dipping the anode-supported tube into the slurry. On the other hand, when the concentration of the YSZ powder is more than 40 wt %,

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the slurry layer coated on the anode-supported tube is too thick to maintain a uniform slurry layer (Col 8 lines 7-20). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate wt. % composition of active material of Song et al. into the solid oxide fuel cell cathode of Kawasaki et al. as modified by Wang et al. in order to obtain a dense uniform slurry layer.

11. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) in view of Seabaugh et al. (U.S. Patent No. 7,595,127 B2).

With respect to claim 14, Kawasaki et al. as modified by Wang et al. disclose a solid oxide fuel cell in paragraph 7 above. Kawasaki et al. as modified by Wang et al. do not specifically teach nickel containing perovskite oxide represented by the formula as claimed by applicant. However, Seabaugh et al. disclose nano composite electrodes wherein, in addition to LSM, PSMF, LSF, and LSCF electrode materials used for preparing the example nano-composite cathode materials, other perovskite electrode materials may be used in the practice of the present invention. These include lanthanum calcium manganite (LCM), lanthanum calcium cobalt ferrite (LCCF), praseodymium strontium manganite (PSM), praseodymium strontium ferrite (PSF), samarium strontium cobaltite (SSC), or other perovskite electrode materials having the formula $(A_{1-x}B_x)(C_{1-y}D_y)O_{3-z}$, where A is a lanthanide element (e.g., La, Pr, Sm, Nd, Gd, Y, etc.), B is an alkaline earth element (e.g., Ca, Sr, or Ba), and C and D are transition elements (e.g., Mn, Fe, Co, Ni or Ti). Other electrically conducting ceramic electrode

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materials, not mentioned above, also can be used to prepare nano-composite cathode material using the methods disclosed herein (Col 8 lines 60-67).

One of ordinary skill in the art would know that electrodes of Kawasaki et al. as modified by Wang et al. can also utilize the electrode materials derived from the formula disclosed by Seabaugh et al. since the electrode material of Seabaugh et al. is used for air electrodes in solid oxide fuel cells. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the electrode materials derived from the formula disclosed by Seabaugh et al. in the fuel cell of Kawasaki et al. as modified by Wang et al. since the electrode material of Seabaugh et al. is used for air electrodes in solid oxide fuel cells. Ex Parte Smith, 83 USPQ.2d 1509, 1518-19 (BPAI, 2007) (citing KSR v. Teleflex, 127 S.Ct. 1727, 1740, 82 USPQ2d 1385, 1396 (2007)).

12. Claims 15 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) in view of Yoshikata et al. (U.S. Pub. No. 2004/0197628 A1).

With respect to claims 15 and 16, Kawasaki et al. as modified by Wang et al. disclose a solid oxide fuel cell in paragraph 7 above. Kawasaki et al. as modified by Wang et al. do not specifically teach wherein the zirconia-containing oxide is zirconia containing scandia or zirconia containing scandia and yttria in solid solution. However, Yoshikata et al. disclose a fuel cell wherein, examples of usable oxygen ion conductive ceramic materials include (Ce, Sm)O₃, (Ce, Gd)O₃, and like ceria-based materials; (La,

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Sr)(Ga, Mg)O₃ and like lanthanum or gallate-based materials; scandium stabilized zirconia (ScSz), yttria stabilized zirconia (YSZ), and like ceramic materials (Paragraph 0042). Yoshikata et al. also teach that the electrolyte, fuel electrode and air electrode are from by using the above materials (Paragraph 0043).

One of ordinary skill in the art would know that electrodes of Kawasaki et al. as modified by Wang et al. can also utilize the electrode materials disclosed by Yoshikata et al. since the electrode material of Yoshikata et al. is used for air electrodes in solid oxide fuel cells. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the electrode materials disclosed by Yoshikata et al. in the fuel cell of Kawasaki et al. as modified by Wang et al. since the electrode material of Yoshikata et al. is used for air electrodes in solid oxide fuel cells. Ex Parte Smith, 83 USPQ.2d 1509, 1518-19 (BPAI, 2007) (citing KSR v. Teleflex, 127 S.Ct. 1727, 1740, 82 USPQ2d 1385, 1396 (2007)).

13. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) and Browall et al. (U.S. Pub. No. 2003/0224232 A1) and further in view of Miyashita et al. (U.S. Patent No. 5,731,097).

With respect to claim 17, Kawasaki et al. as modified by Wang et al. and Browall et al. disclose a solid oxide fuel cell in paragraph 8 above. Kawasaki et al. as modified by Wang et al. and Browall et al. do not specifically teach wherein the cerium oxide is

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represented by the formula as claimed by Applicant in claim 17. However, Miyashita et al. disclose a solid electrolyte fuel cell wherein, of conventional solid electrolytes, it is said that a CeO_2 -based electrolyte doped with Sm, which is represented by a formula of $(\text{CeO}_2)(\text{Sm}_2\text{O}_3)_{1-x}$ where x is a real number that is greater than 0 and less than 1, has the smallest resistance against the oxygen ion movement therethrough (Col 2 lines 1-10). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate solid oxide material of Miyashita et al. into the solid oxide fuel cell cathode of Kawasaki et al. as modified by Wang et al. and Browall et al. as modified by Wang et al. because Miyashita et al. teach that this solid oxide has the smallest resistance against oxygen ion movement (Col 2 lines 1-10).

14. Claims 18 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) in view of Nishihara et al. (Japanese Patent No. 2002-134132)

With respect to claim 18, Kawasaki et al. as modified by Wang et al. disclose a solid oxide fuel cell in paragraph 7 above. Kawasaki et al. as modified by Wang et al. do not specifically teach wherein the air-side electrode reaction layer comprises at least two layers of a first layer on the air electrode side and a second layer on the electrolyte side. However, Nishihara et al. disclose a solid oxide fuel cell wherein, in the solid oxide fuel cell of this invention, the Mn diffusion prevention layer 41 which consists of an oxide containing Y, Zr, and Ce is formed between the solid electrolyte 31 and the air pole 32. As for this Mn diffusion prevention layer 41, it is desirable that they are

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CeO₂ in which Y and Zr dissolved, ZrO₂ in which Y and Ce dissolved, or those mixtures, and its things are dissolving Zr and Y in CeO₂ especially desirable (Paragraph 0029).

After applying to the surface of a cylindrical air pole temporary-quenching object, forming the coating film of the diffusion prevention layer 41 and laminating a solid electrolyte Plastic solid and a fuel electrode Plastic solid one by one, by carrying out simultaneous calcination, Between a solid electrolyte and an air pole, the diffusion prevention layer 41 containing Y, Zr, and Ce is formed, by this diffusion prevention layer 41, diffusion of Mn from an air pole to a solid electrolyte can be controlled, and the diffusing capacity of Mn in a fuel electrode can be decreased (Paragraph 0045).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the bi-layer cathode of Nishihara et al. in the fuel cell of Kawasaki et al. as modified by Wang et al. because Nishihara et al. teach that diffusion of MN from the air electrode to the solid electrolyte can be controlled and the diffusion capacity of Mn in the fuel electrode can be decreased (Paragraph 0045).

With respect to claim 31, Kawasaki et al. teach that in first, second, third, fourth and fifth aspects of the present invention, the air electrode may be formed of doped or undoped LaMnO₃, CaMnO₃, LaNiO₃, LaCoO₃, LaCrO₃ or the like, among which LaMnO₃ doped with strontium or calcium is preferable. These doped or undoped LaMnO₃, CaMnO₃, LaNiO₃, LaCoO₃ and LaCrO₃ include a composite oxide having a perovskite structure in which its A site and B site are not substantially deficient, and include a composite oxide in which a part of the A site or B site is deficient, for example,

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in which La or Ca is contained in the A site and a part of the A site is deficient. Such composite oxide, in which La or Ca is contained in the A site and a part of the A site is deficient, effectively reduce the formation of $\text{La}_2\text{Zr}_2\text{O}_7$. Generally, the air electrode may be preferably made of a nickel-zirconia cermet or a cobalt-zirconia cermet (Col 17 lines 5-25).

15. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) and Nishihara et al. (Japanese Patent No. 2002-134132) and further in view of Shibata et al. (U.S. Patent No. 7,226,691 B2).

With respect to claim 24, Kawasaki et al. as modified by Wang et al. and Nishihara et al. disclose a solid oxide fuel cell in paragraph 14 above. Kawasaki et al. as modified by Wang et al. and Nishihara et al. do not specifically teach wherein the diameter of the pores in the second layer is 0.1 to 10 μm . However, Shibata et al. disclose a solid oxide fuel cell wherein, even though the electrode layer 12 as the low porosity layer has the porosity, as will be described in detail later, which is selected to be lower than that of the substrate 10 as the high porosity layer, the electrode layer 12 has a plurality of pores P (involving open pores, closed pores and those termed as voids) each having a diameter (corresponding to the maximum diameter regarding the inner bailey of the pore P and referred to as a size) ranging in a value equal to or less

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than 10 μm more preferably, such a pore diameter may fall in a value equal to or less than 5 μm . Also, the presence of the diameter exceeding 10 μm is not preferred because there is a need for a thick film to be made thereon in order to form a non-defective continuous film. Namely, the provision of such an electrode layer 12 as the low porosity layer enables thin film layers 14, 16 to be formed thereon with no need for carrying out grinding or polishing operation on the electrode layer 12. As a consequence, internal resistance of the cell 1 decreases and, so, it becomes possible to realize the SOFC with a high power output and low temperature operating capability. Moreover, due to an ability of the cell 1 being formed in a thin planar structure as a whole, the cell 1 is enabled to be formed in a light weight and miniaturized structure. Also, although the pores of the substrate 10 as the high porosity layer are similarly designated by P for the sake of convenience, it is objectionable for the diameters of the pores to be different from those of the electrode layer 12 as the low porosity layer (Col 4 lines 19-45). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the pore sizes of Shibata et al. into the second electrode layer of Kawasaki et al. as modified by Wang et al. and Nishihara et al. because Shibata et al. teach that as a consequence, internal resistance of the cell 1 decreases and, so, it becomes possible to realize the SOFC with a high power output and low temperature operating capability (Col 4 lines 19-45).

16. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No.

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6,653,009 B2) and Nishihara et al. (Japanese Patent No. 2002-134132) and further in view of Jacobson et al. (U.S. Pub. No. 2002/0081762 A1).

With respect to claim 26, Kawasaki et al. as modified by Wang et al. and Nishihara et al. disclose a solid oxide fuel cell in paragraph 14 above. Kawasaki et al. as modified by Wang et al. and Nishihara et al. do not specifically teach wherein the second layer has a porosity of 3 to 40%. However, Jacobson et al. disclose a solid oxide fuel cell wherein, the fired electrode/electrolyte/ electrode trilayer will shrink, for example, on the order of about 5-25% as the materials sinter and the structure densities. The fired electrolyte 314 must be sufficiently densified to provide a gas-tight barrier between the gases at each electrode. The fired electrode 312 and 315 is preferably at least 90% densified (about 10% porosity), and may be as much as about 95% densified, or even about 98% densified. After the firing, the electrode remains porous, in one embodiment to less than about 80% dense (preferably about 60 to 70% dense (about 30 to 40% porosity), in order to allow gases to diffuse through the electrode or to it (Paragraph 0066). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the electrode porosity of Jacobson et al. into the second electrode layer of Kawasaki et al. as modified by Wang et al. and Nishihara et al. because Jacobson et al. teach that this porosity allows gasses to diffuse through the electrode (Paragraph 0066).

17. Claims 28 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No.

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6,653,009 B2) and Nishihara et al. (Japanese Patent No. 2002-134132) and further in view of Carolan et al. (U.S. Patent No. 5,750,279).

With respect to claims 28 and 29, Kawasaki et al. as modified by Wang et al. and Nishihara et al. disclose a solid oxide fuel cell in paragraph 14 above. Kawasaki et al. as modified by Wang et al. and Nishihara et al. do not specifically teach wherein the first and second layer has a thickness of 5 to 50 μ m. However, Carolan et al. disclose a solid oxide fuel cell wherein, the thickness of the anode or cathode on the ceramic electrolyte is generally between about 0.1 microns and about 100 microns, and preferably between about 1 to about 20 microns. The electrode layers are preferably thin in order to allow movement of gases freely therethrough. When very thin electrodes are used it may be desirable to use a current conductor, such as a metallic grid or a composite of the electrode with a silver coating applied over the electrode to minimize sheet resistance. From an ion transport standpoint, very thin electrolytes are preferred so long as the electrolyte possesses sufficient structural integrity. From a structural standpoint, thicker electrolytes may be required, especially if there is, or could be, a significant pressure differential across the electrolyte (Col 4 lines 5-30). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the cathode thickness of Carolan et al. into the second and first electrode layers of Kawasaki et al. as modified by Wang et al. and Nishihara et al. because Carolan et al. teach that the electrode layers are preferably thin in order to allow movement of gases freely therethrough (Col 4 lines 5-30).

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18. Claims 30 and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No. 6,653,009 B2) and Nishihara et al. (Japanese Patent No. 2002-134132) and further in view of Miyashita et al. (U.S. Patent No. 5,731,097).

With respect to claims 30 and 33, Kawasaki et al. as modified by Wang et al. and Nishihara et al. disclose a solid oxide fuel cell in paragraph 14 above. Kawasaki et al. as modified by Wang et al. and Nishihara et al. do not specifically teach wherein the cerium oxide is represented by the formula as claimed by Applicant in claim 30. However, Miyashita et al. disclose a solid electrolyte fuel cell wherein, of conventional solid electrolytes, it is said that a CeO_2 -based electrolyte doped with Sm, which is represented by a formula of $(\text{CeO}_2)(\text{Sm}_2\text{O}_3)_{1-x}$ where x is a real number that is greater than 0 and less than 1, has the smallest resistance against the oxygen ion movement therethrough (Col 2 lines 1-10). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate solid oxide material of Miyashita et al. into the solid oxide fuel cell cathode of Kawasaki et al. as modified by Wang et al. and Nishihara et al. as modified by Wang et al. because Miyashita et al. teach that this solid oxide has the smallest resistance against oxygen ion movement (Col 2 lines 1-10).

19. Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Wang et al. (U.S. Patent No.

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6,653,009 B2) and Nishihara et al. (Japanese Patent No. 2002-134132) in view of Seabaugh et al. (U.S. Patent No. 7,595,127 B2).

With respect to claim 32, Kawasaki et al. as modified by Wang et al. and Nishihara et al. disclose a solid oxide fuel cell in paragraph 14 above. Kawasaki et al. as modified by Wang et al. and Nishihara et al. do not specifically teach nickel containing perovskite oxide represented by the formula as claimed by applicant. However, Seabaugh et al. disclose nano composite electrodes wherein, in addition to LSM, PSMF, LSF, and LSCF electrode materials used for preparing the example nano-composite cathode materials, other perovskite electrode materials may be used in the practice of the present invention. These include lanthanum calcium manganite (LCM), lanthanum calcium cobalt ferrite (LCCF), praseodymium strontium manganite (PSM), praseodymium strontium ferrite (PSF), samarium strontium cobaltite (SSC), or other perovskite electrode materials having the formula $(A_{1-x}B_x)(C_{1-y}D_y)O_{3-z}$, where A is a lanthanide element (e.g., La, Pr, Sm, Nd, Gd, Y, etc.), B is an alkaline earth element (e.g., Ca, Sr, or Ba), and C and D are transition elements (e.g., Mn, Fe, Co, Ni or Ti). Other electrically conducting ceramic electrode materials, not mentioned above, also can be used to prepare nano-composite cathode material using the methods disclosed herein (Col 8 lines 60-67).

One of ordinary skill in the art would know that electrodes of Kawasaki et al. as modified by Wang et al. and Nishihara et al. can also utilize the electrode materials derived from the formula disclosed by Seabaugh et al. since the electrode material of Seabaugh et al. is used for air electrodes in solid oxide fuel cells. Therefore it would

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have been obvious to one of ordinary skill in the art at the time the invention was made to use the electrode materials derived from the formula disclosed by Seabaugh et al. in the fuel cell of Kawasaki et al. as modified by Wang et al. and Nishihara et al. since the electrode material of Seabaugh et al. is used for air electrodes in solid oxide fuel cells.

Ex Parte Smith, 83 USPQ.2d 1509, 1518-19 (BPAI, 2007) (citing KSR v. Teleflex, 127 S.Ct. 1727, 1740, 82 USPQ2d 1385, 1396 (2007)).

20. Claims 34-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Baozhen et al. (U.S. Patent No. 6,207,311 B1).

With respect to claims 34-36, Kawasaki et al. disclose a solid oxide fuel cell in paragraph 5 above. Kawasaki et al. do not specifically teach an electrolyte with at least two layers as claimed by Applicant. However, Baozhen et al. disclose a solid oxide fuel cell wherein, an improved electrolyte in the form of Sc_2O_3 -stabilized zirconia (ScSZ) having higher electrical conductivity than conventional yttria-stabilized zirconia (YSZ) is provided. The use of a ScSZ electrolyte combined with an improved interface layer (second layer) in a solid oxide fuel cell in accordance with the present invention has been found to substantially increase the operable temperature range of the SOFC, by substantially improving the operation at temperatures below 1000.degree. C. The ScSZ electrolyte may be provided as a very thin layer in order to reduce resistance. The ScSZ electrolyte is preferably used in combination with a YZTb interface layer between

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the air electrode and electrolyte which reduces interfacial resistance and air electrode polarization in the SOFC (Col 2 lines 35-50). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the bi-layer electrolyte of Baozhen et al. in the fuel cell of Kawasaki et al. because Baozhen et al. teach that the bi-layer electrolyte reduces interfacial resistance and air electrode polarization in the SOFC (Col 2 lines 35-50).

21. Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Sarkar et al. (U.S. Pub. No. 2004/0121222 A1) and further in view of Jacobson et al. (U.S. Pub. No. 2002/0081762 A1).

With respect to claim 42, Kawasaki et al. as modified by Sarkar et al. disclose a solid oxide fuel cell in paragraph 6 above. Kawasaki et al. as modified by Sarkar et al. do not specifically teach wherein the second layer has a porosity of 3 to 40%. However, Jacobson et al. disclose a solid oxide fuel cell wherein, the fired electrode/electrolyte/electrode trilayer will shrink, for example, on the order of about 5-25% as the materials sinter and the structure densities. The fired electrolyte 314 must be sufficiently densified to provide a gas-tight barrier between the gases at each electrode. The fired electrode 312 and 315 is preferably at least 90% densified (about 10% porosity), and may be as much as about 95% densified, or even about 98% densified. After the firing, the electrode remains porous, in one embodiment to less than about 80% dense (preferably about 60 to 70% dense (about 30 to 40% porosity), in order to allow gases

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to diffuse through the electrode or to it (Paragraph 0066). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the electrode porosity of Jacobson et al. into the second electrode layer of Kawasaki et al. as modified by Sarkar et al. because Jacobson et al. teach that this porosity allows gasses to diffuse through the electrode (Paragraph 0066).

22. Claim 44 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Sarkar et al. (U.S. Pub. No. 2004/0121222 A1) and further in view of Jankowski et al. (U.S. Pub. No. 2003/0013002 A1).

With respect to claim 44, Kawasaki et al. as modified by Sarkar et al. disclose a solid oxide fuel cell in paragraph 6 above. Kawasaki et al. as modified by Sarkar et al. do not specifically teach wherein the diameter of pores in the porous layer formed of the fluorite oxide is 0.05 to 2 μ m. However, Jankowski et al. disclose a solid oxide fuel cell wherein, a porous thin-film anode or cathode structure may be formed from a host structure or substrate having a high percentage of continuous open porosity, e.g., greater than 40% by volume (measured by mercury porosimetry). Examples of such substrates include anodized alumina, silicon that has been anisotropically etched, or a polycarbonate film that has been irradiated by heavy ions and selectively etched by potassium hydroxide. The pores sizes in such a structure nominally range from about 0.05 μ m to about 1 μ m in average cross-sectional diameter (measured by scanning electron microscopy or optical microscopy), are closely spaced, and are

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continuous throughout the substrate/host structure (Paragraph 0020). Jankowski et al. also teach that features such as pore size and operating temperature will determine the rate at which fuel and oxidant can be passed through the fuel cell. For example, smaller pore size can be desirable in a low temperature PEM cell that generates up to about 0.1 watts/cm.², whereas larger pore size can be desirable in a high temperature SOFC that generates up to about 2 watts/cm.². Thus, the ability to tailor the pore size of electrodes to operating temperatures and other parameters of fuel cells can create very efficient energy systems (Paragraph 0023).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the electrode pore size of Jankowski et al. into the fluorite oxide layer of Kawasaki et al. as modified by Sarkar et al. because Jankowski et al. teach that smaller pore size can be desirable in a low temperature PEM cell that generates up to about 0.1 watts/cm.², whereas larger pore size can be desirable in a high temperature SOFC that generates up to about 2 watts/cm.². Thus, the ability to tailor the pore size of electrodes to operating temperatures and other parameters of fuel cells can create very efficient energy systems (Paragraph 0023).

23. Claims 45-46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (U.S. Patent No. 5,527,633) in view of Sarkar et al. (U.S. Pub. No. 2004/0121222 A1) and further in view of Yoshikata et al. (U.S. Pub. No. 2004/0197628 A1).

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With respect to claims 45 and 46, Kawasaki et al. as modified by Sarkar et al. disclose a solid oxide fuel cell in paragraph 6 above. Kawasaki et al. as modified by Sarkar et al. do not specifically teach wherein the zirconia-containing oxide is zirconia containing scandia or zirconia containing scandia and yttria in solid solution. However, Yoshikata et al. disclose a fuel cell wherein, examples of materials forming the fuel electrode include include $(\text{Ce}, \text{Sm})\text{O}_3$, $(\text{Ce}, \text{Gd})\text{O}_3$, and like ceria-based materials; $(\text{La}, \text{Sr})(\text{Ga}, \text{Mg})\text{O}_3$ and like lanthanum or gallate-based materials; scandium stabilized zirconia (ScSz), yttria stabilized zirconia (YSZ), and like ceramic materials (Paragraph 0042).

One of ordinary skill in the art would know that electrodes of Kawasaki et al. as modified by Wang et al. can also utilize the electrode materials disclosed by Yoshikata et al. since the electrode material of Yoshikata et al. is used for fuel electrodes in solid oxide fuel cells. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the electrode materials disclosed by Yoshikata et al. in the fuel cell of Kawasaki et al. as modified by Wang et al. since the electrode material of Yoshikata et al. is used for fuel electrodes in solid oxide fuel cells. Ex Parte Smith, 83 USPQ.2d 1509, 1518-19 (BPAI, 2007) (citing KSR v. Teleflex, 127 S.Ct. 1727, 1740, 82 USPQ2d 1385, 1396 (2007)).

Allowable Subject Matter

Claims 19-23 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 25 and 27 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 37 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 43 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ben Lewis whose telephone number is 571-272-6481. The examiner can normally be reached on 8:30am - 5:30pm.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/Ben Lewis/
Examiner, Art Unit 1795

/PATRICK RYAN/
Supervisory Patent Examiner, Art Unit 1795